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DEVELOPMENT OF A NEW PACKAGE TO EVALUATE COMPACT URBAN LAYOUT: SLIM CITY

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Abstract

Though several studies have already pointed out that the building of a compact urban layout is an essential for a better environment, not enough statistical information for decision-making has been provided. This study aims to develop a new package that provides a list of indicators to realize compact urban layout efficiently. The package, SLIM CITY (Smart Layout Indicators to Materialize Compact City), is based on statistical data that cover town characteristics (land-use and infrastructures) and transportation behaviors of residents. This system can provide a package of indicators to evaluate compact urban layout, including gasoline consumption, livability of the town center, time consumed for transportation, and the social mix of residents. The most powerful point of this system is that indicators are calculated on a town (residential zone) scale, not on a city (municipal) scale. Moreover, any town can be examined easily by this system. A case study using this system was also executed. Several scenarios concerning compact urban form were examined in Kure city, Japan, using SLIM CITY. In this study, the compact land-use scenario with improvement of public transport service shows large compound effects on indicators.

Keywords: Compact city; Evaluation; Urban layout; Automobile usage
Topic area: F1 Transport and Spatial Development

1 Introduction

Many Transportation Demands Management (TDM) measures have been used to improve the environment of urban transport. These measures have included park-and-ride, flextime commuting, and the use of toll fees. In general, these schemes focus solely on transportation and not on urban layout. Though these measures could effectively improve specific urban transportation problems, it would be very difficult to curb the trend toward a growing reliance on the automobile.

Several studies have suggested that a compact urban layout is essential for solving these problems. If urban layout were well managed, society would be more sustainable. However, there is too little quantitative information describing the optimum or preferable compact urban layout. It is necessary to execute a statistical analysis based on accurate estimates of travel requirements and land-use information to establish the basic parameters of a compact urban layout.

The objective of this study is to develop a new evaluation package of compact urban layout, SLIM CITY (Smart Layout Indicators to Materialize Compact City). The basic requirement for this system is to define important factors of a compact urban layout from a town scale. The town scale defines the neighborhood level or a residential scale in this study. Not only a higher population density but also possibilities for improvement of public transport, land use control, and other compound factors should be examined as important factors of a compact urban layout. As it is not realistic to construct a whole new future city, the package must be developed on a town scale, not on a city (municipal) scale. The accumulation of town-scale improvement projects will lead to the future realization of compact urban layouts on a city scale. The National Person Trip Survey (NPTS) that was executed in Japan is adopted as the trip data source for this package.

In SLIM CITY, town-scale analysis is used to determine the relationship between the characteristics of each residential area and the indicators to evaluate a compact urban layout, such as automobile usage (gasoline consumption), time in the city (livability of a town center), time consumed for transportation, and social mix of residents. A statistical analysis based on the scale of the town has not previously been examined. The town-scale analysis is described briefly based on the three following points:

1) Designation of Towns: As the total number of residential zones in NPTS is about 2,000, it is necessary to designate groups of residential zones for an effective town-scale analysis. The characteristics of each residential zone, such as location, population density, land-use control, transportation conditions, and distance from the city center, were examined as index factors to designate groups of residential zones.

2) Estimation of Indicators: A model approach, such as the multiple regression model, was adopted to estimate such indicators as automobile usage (gasoline consumption). The dependent variable of this model is per capita gasoline consumption in each group of residential zones. The independent variables are population density, location, land-use control, conditions of public transportation, and mixed conditions of land use.

3) Case Study by Scenario: SLIM CITY can be utilized for many types of towns very easily. A case study of SLIM CITY provides several scenario menus to cover a wide range of urban improvement alternatives.

2 Previous studies and SLIM CITY

2.1 Previous studies

The relationship between urban form and the behavior of residents has been investigated, especially on a city (municipal) scale, not on a town scale. Thomson (1977) was one of the first researchers to discuss the relationship between an urban layout and its transportation network. Though many publications have encouraged a more compact urban layout for sustainable development since then, only a few studies have quantitatively addressed the relationship between urban layout and automobile usage. Newman and Kenworthy (1989) calculated the relationship between urban population density and per capita annual gasoline consumption on a municipal scale. Their results clearly show that cities with a low density rely on automobile transportation. Jenks, Burton, and Williams (1996), Naess (1996), Roo and Miller (2000), and Williams, Burton, and Jenks (2000) also investigated the relationship between urban layout and transportation, and their findings shed new light on the improvement of the urban layout.

Though these findings suggest that compact urban form and high population density are desirable, no quantitative guidelines or packages for urban improvement projects have been developed. Moreover, other factors affecting urban form, with the exception of population density, have not been statistically investigated.

2.2 The concept and structure of SLIM CITY

SLIM CITY provides a package of indicators to evaluate compact urban layout, such as gasoline consumption, livability of a town center, time consumed for transportation, and social mix of residents. This study focuses on the following points regarding SLIM CITY:

1) Statistical Approach: Current studies that outline preferences for compact urban layout are required to present reliable and quantifiable information. This study uses a multiple regression model based on a sufficient number of trip samples with accurate land-use information to confirm the basic factors of compact urban layout.

2) Wide Coverage of Factors and Indicators: This study considers not only population density as a factor of a compact city but also other important factors, such as public transportation service, road infrastructure, historic background, and regional characteristics. SLIM CITY can provide a package of indicators to evaluate compact urban layout, such as gasoline consumption, livability of a town center, time consumed for transportation, and social mix of residents. Some indicators, such as gasoline consumption, are estimated by the multi-regression model with related factors, and other indicators are calculated directly.

3) Town-Scale Analysis: An objective of this study is to clarify important factors for compact urban layout on a town scale. A town scale defines the neighborhood level (mostly under 100ha), which is the scale for a residential area in this study. Local urban improvement projects for compact urban layouts require very detailed information based on the town scale.

4) Wide Applicability: The most important point of SLIM CITY is that it can be applied to any type of town. This strength is realized by an original database of residential zones that covers the metropolis to the local city in Japan. In this regard, the method of SLIM CITY is completely different from those of the usual land-use transportation models.

5) Operational System: The most popular way to utilize SLIM CITY is to input the type of town and possible menus to improve that town, such as densification of population, improvement of public transport, and improvement of infrastructure. The output is how that town changes its town type by each menu. If you compare indicators of these new and old types, you can find the most suitable improvement menu for that town.

6) Simple System: The key structure of SLIM CITY is the classification of towns. The characteristics of each town (residential zone), such as the location, population density, land-use control, transportation conditions, and distance from the city center, are examined as index factors to designate groups of towns. If you can identify the type of town, SLIM CITY provides you with detailed indicators to evaluate the compactness of that town. This means that it is not necessary to estimate an OD trip pattern or network assignment calculation.

3 Data and methods

3.1. Data and samples

In Japan, Metropolitan Person Trip Surveys (MPTS) have been conducted in major cities and metropolitan areas for the past three decades. Though they provide rich information, they are inappropriate for use here. This study requires trip data from many cities based on the same standard. As a result, for this study, trip data from the National Person Trip Survey (NPTS) are preferable to the usual MPTS data.

The Ministry of Construction of Japan has conducted NPTSs three times so far. Sample cities of the NPTS were selected to cover a variety of cities (Figure 1). Specifically, the following three points were considered:

a) The population of the city,

b) the population of the metropolitan area that the city belongs to, and

c) the location (e.g., center or periphery) of that city in the metropolitan area.

In this study, the local cities chosen are not in the three major metropolitan areas of Tokyo, Osaka, and Nagoya.

Each household filled out the two-page NPTS. Part of it deals with household attributes, and the other seeks information about trips made by each family member. The NPTS also includes questions about the possibility of automobile usage for each family member.

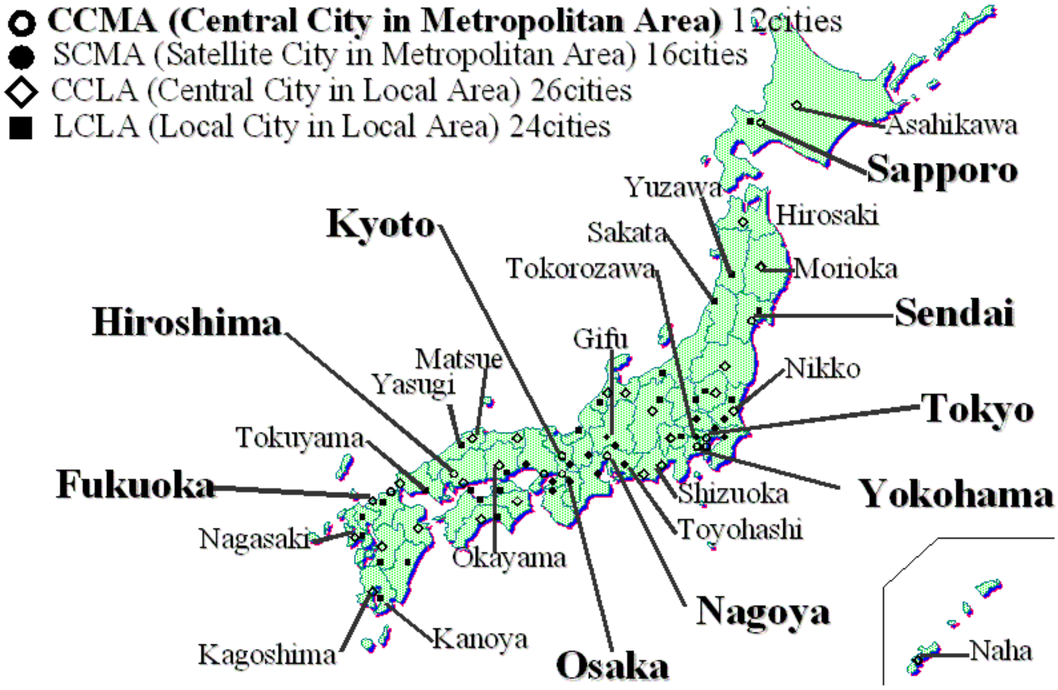

Figure 1. Sample cities (1992 National Person Trip Survey)

Questionnaires were distributed to at least 360 households in each sample city. During the 1992 survey, the total number of household questionnaires was 29,502, and that of personal questionnaires was 80,997. Investigators visited all the selected households to distribute and collect the questionnaires. A total of 25,009 household and 67,067 personal questionnaires were collected. The effective personal return rate was 82.8%. It is statistically guaranteed that this collection rate is large enough to reproduce basic transportation characteristics, such as average trip length in each city (Ministry of Construction 1993). The special strength of the NPTS data is that many cities were surveyed with the same standards over the same period of time. From the restriction of land-use data, a sample scale of SLIM CITY extends to 70 cities with 57,243 persons, as extracted from the NPTS.

3.2 Classification of residential zones (designation of towns)

As the total number of residential zones (towns) in NPTS is as high as 1,996, it is necessary to designate groups of towns for an effective town-scale analysis. The characteristics of each town, such as the location, population density, land-use control, transportation conditions, and distance from the city center, are examined as index factors to designate groups of towns (Table 1). Consequently, 138 groups of residential zones, namely towns, are designated, and each of them indicates a variety of trip patterns by residents in each area.

3.3 Estimation of gasoline consumption

One of the most important indicators, the quantity of gasoline consumed during each trip, was estimated with the following equation (Kaneyasu and Kanaizumi 1972). x is calculated from the trip distance and time required, which were obtained from the NPTS.

$$q_{[cc/km]} = 0.290 x_{[s/km]} + 49.3 \quad \cdots\cdots (1)$$

x : (vehicle speed)$^{-1}$

This consumption volume on weekdays is converted into energy use with the following coefficient.

Gasoline 1,000cc: 720 g

Gasoline 1 kg: 44.1 MJ (Hayashi et al. 1995)

The multiple regression model was adopted to evaluate the factors of urban layout and their effects on gasoline consumption. Namely, the dependent variable (Y) of the regression model is per capita gasoline consumption. Several types of regression equations have been tested, and the following log-linear model has the best fit of all models:

$$\ln Y = a_1 X_1 + a_2 X_2 + \cdots + a_n X_n + b \quad \cdots\cdots (2)$$

4 Results concerning gasoline consumption

A variety of explanatory variables for the estimation of gasoline consumption are shown in Table 2 and Table 3. The variables include, among others, land-use intensity, infrastructure conditions, and transportation conditions. The explanatory variables were finally adopted after checking to avoid multicollinearity.

The parameters and t-values shown in Table 4 show a clear image of the relationship between urban layout concerning town-scale development and automobile energy consumption, as follows:

1) In spite of other factors, population density is the most significant in explaining gasoline consumption.

2) If a town is located close to a city center, gasoline consumption decreases. The distance from a city center, which translates exactly into compact residential development, is then very significant. This means that the execution of infill-type development is an effective countermeasure to reduce gasoline consumption.

3) Railway-convenient zones in a local area discourage automobile usage. Railway zones that are inconvenient in a satellite city of a metropolitan area encourage automobile

usage.

Table 1. Characteristics of a residential zone for grouping of residential zones

Items	Categories		
City Type	Central City in Metropolitan Area (CCMA)		
	Satellite City in Metropolitan Area (SCMA)		
	Central City in Local Area (CCLA)		
	Local City in Local Area (LCLA)		
Land Use	Urbanization Control Area Type	Urbanization Control Area	25%～50%
			50%～75%
			75%～
	Residential Type	Low-height Residential District Use	90%～
			60%～90%
		High and Medium-height Residential District Use	90%～
			60%～90%
		General Residential District Use	60%～
	Commercial Type	Neighborhood Com. District Use	60%～
		Commercial District Use	60%～
	Industrial Type	Light Industrial District Use	60%～
		Ind. and Exclusive Ind. District Use	60%～
	Residential-Commercial Mixed Type (Residential Type: 60%～80%)		
	Mixed Use Type	Mixed-Use Residential (Largest: Residential-Type District)	
		Mixed-Use Commercial (Largest: Commercial-Type District)	
		Mixed-Use Industrial (Largest: Industrial-Type District)	
Population Density	～50 (persons/ha)		
	50～100		
	100～150		
	150～		
Transportation Conditions	Distance to the Nearest Station	Near: ～1km	
		Far: 1km～	
	Frequency of Train Service at the Nearest Station per	～114	
		114～	
Distance from the City Center	～1.6km		
	1.6km～5km		
	5km～		

4) The type of city that each town belongs to significantly affects the rate of gasoline consumption as well. If a town is located in a local area, gasoline consumption increases considerably.

5) Residential and neighborhood commercial zoning tends to increase gasoline consumption.

6) Compound factors occupy a very important place in this model. They show the possibilities of a combination of different policies.

7) For example, mixed-use residential zoning is a very interesting factor. In a metropolitan area, mixed-use residential zoning shows a minus parameter. In a non-metropolitan area, mixed-use residential zoning indicates a plus parameter. These results show that the popular idea that mixed use is desirable for a transportation environment is not always true, especially outside a metropolitan area.

Table 2. Definition of each variable

Explanatory Variables		Definition and Remarks
Population	Population Density	Persons/ha
Location	Distance** from City Center	km
Transportation Conditions	Distance** from Bus Stop	Distance** between the center of the zone and the nearest bus stop (km)
	Satellite City in Metropolitan Area: Railway-Inconvenient	Distance** to the nearest railway station is more than 2km, or train service at nearest station is less than 260 services
	Central City in Local Area: Railway-Convenient (D)*	Train service at nearest station is more than 160 services per day
	Local City in Local Area: Railway-Convenient (D)*	Distance* to the nearest railway station is less than 2km, and train service at nearest station is more than 90 services
City Type	Central City in Metropolitan Area (D)*	Cities designated by ordinance or cities with more than one million population
	Central City in Local Area (D)*	Prefectural capitals and cities with a population of more than 150 thousand
	Local City in Local Area (D)*	Local cities with a population of less than 150 thousand (excluding prefectural capitals)
Land Use	Residential Zoning (D)*	Zones in which more than 60% is assigned to R-Ⅰ, Ⅱ or Ⅲ
	Neighborhood Commercial Zoning (D)*	Zones in which more than 60% is assigned to C-Ⅱ
	Light Industrial Zoning (D)*	Zones in which more than 60% is assigned to I-Ⅰ
Compound Factors	Industrial Zoning (D)*	Zones in which more than 60% is assigned to I-Ⅱ
	LCLA + Large UCA (D)*	Zones at LCLA in which the UCA covers more than 50%
	CCMA or CCLA + UCA (D)*	Zones at central cities in which the UCA covers between 25% and 50%
	Local Area + UCA (D)*	Zones at the local area in which the UCA covers between 25% and 50%
	Adjoining Station + High and R-Ⅱ (D)*	Zones adjoining the railway station in which R-Ⅱ use exceeds 60%
	CCMA + Mixed-Use Residential Zoning (D)*	Zones at the metropolitan area, with high population density, and mixed-use residential zoning
	Non CCMA + Mixed-Use Residential Zoning (D)*	Mixed-use residential zoning (excluding Metropolitan Area + Mixed-Use Residential Zoning)
	Metropolitan Area + R-Ⅰ (D)*	Zones at the metropolitan area in which R-Ⅰ use exceeds
	Local Area + R-Ⅰ (D)*	Zones at the local area in which R-Ⅰ use exceeds 60%
	Metropolitan Area + Adjoining Station + R-Ⅰ (D)*	Zones at the metropolitan area adjoining the railway station in which R-Ⅰ use exceeds 60%

*D: Dummy
**) All distances are measured from the center of each residential zone

Table 3. Zoning control

Urbanization Promotion Area		abbreviation
	Exclusively Residential Zone for Low-height Buildings (class1)	R-Ⅰ
	Exclusively Residential Zone for Low-height Buildings (class2)	
	Exclusively Residential Zone for High-and-Medium-height Buildings (class1)	R-Ⅱ
	Exclusively Residential Zone for High-and-Medium-height Buildings (class2)	
	Residential Zones (class1)	R-Ⅲ
	Residential Zones (class2)	
	Semi-Residential Zone	
	Neighbourhood Commercial Zone	C-Ⅰ
	Commercial Zone	C-Ⅱ
	Light-Industrial Zone	I-Ⅰ
	Industrial Zone	I-Ⅱ
	Exclusively Industrial Zone	
Urbanization Control Area		UCA

Table 4 Factors that affect town scale gasoline consumption

Explanatory Variables		Standardized Parameter	t value
Population	Population Density	-0.392	-5.26
Location	Distance from City Center	0.299	3.48
Transportation Conditions	Distance from Bus Stop	0.125	2.13
	Satellite City in Metropolitan Area: Railway-Inconvenient (D)	0.156	2.43
	Central City in Local Area: Railway-Convenient (D)	-0.107	-1.82
	Local City in Local Area: Railway-Convenient (D)	-0.085	-1.46
City Type	Central City in Metropolitan Area (D)	-0.177	-2.21
	Central City in Local Area (D)	0.336	4.41
	Local City in Local Area (D)	0.284	3.16
Land Use	Residential Zoning (D)	0.373	4.38
	Neighborhood Commercial Zoning (D)	0.266	4.49
	Light Industrial Zoning (D)	0.168	2.33
	Industrial Zoning (D)	-0.222	-3.30
Compound	LCLA + Large UCA (D)	0.152	2.47
Factors	CCMA or CCLA + UCA (D)	-0.100	-1.62
	Local Area + UCA (D)	0.154	2.66
	Adjoining Station + High and R-Ⅱ (D)	-0.109	-1.89
	Metropolitan Area + Mixed-Use Residential Zoning (D)	-0.103	-0.96
	Non CCMA + Mixed-Use Residential Zoning (D)	0.185	3.15
	Metropolitan Area + R-Ⅰ (D)	-0.169	-3.06
	Local Area + R-Ⅰ (D)	0.130	2.40
	Metropolitan Area + Adjoining Station + R-Ⅰ (D)	-0.196	-3.63
Segment			8.65
Adjusted R^2		0.652	

8) If a town adjoins a railway station, gasoline consumption decreases. This is also a typical example of a compound effect.

9) Agglomeration of residences with low height shows a different effect between a metropolitan area and a local area. In the case of a local area, an exclusive agglomeration of low-rise residences tends to increase gasoline consumption.

Based on these findings, practical guidelines, such as those given in Figure 2, which encourage a compact city to reduce automobile usage, are provided in the SLIM CITY system. Figure 2 shows the case of a central city in a local area (CCLA). Each town in a CCLA can be plotted on this space. The arrows in Figure 2 show characteristic differences among towns: each arrow expresses the improvement required to reduce automobile usage. Developers and planners should be required to refer to these guidelines. Clear visual images of each town plotted in Figure 2 can be obtained in Figure 3.

5. Case study

5.1 Case city and scenarios

A case study by using SLIM CITY was also executed. Several scenarios concerning compact urban form were examined in Kure city by using SLIM CITY. Kure city is located in the Chugoku region of western Japan, and its present population is about 200,000. It is a typical Central City in Local Area with a declining downtown and with sprawl development in the suburbs. There are 362 residential zones (towns) in Kure city, and required variables by Figure 1 for SLIM CITY analysis are collected by each town.

Based on these data, each town is classified into one of 138 groups of towns. According to changes caused by the following scenarios, each town would transfer to another group. As indicators show different numbers corresponding to each group of town, impacts on indicators by scenarios are derived easily. Each scenario is evaluated per capita and by the city total. Table 5 indicates the concept of each scenario. The base year is 2002, and the target year is 2010. Two population frames are provided: the no-growth type (203,056) and the growth type (240,000). The scenario of dispersion means that sprawl development cannot be stopped. A compound scenario concerning compact urban layout and improvement of public transportation service is also examined.

5.2 Results of the case study

The results of indicators, such as gasoline consumption, total duration time in the city (livability of a town center), time consumed for transportation, and social mix of residents, are calculated for each scenario. As it is impossible to show all the results, some typical results are exhibited in Figure 4 to Figure 7.

Figure 4 and Figure 5 indicate how urban layout could reduce gasoline consumption. Though a compact scenario would reduce per capita gasoline consumption, the reduction in the whole city is not enough. The compact scenario with improved public transport could minimize the effect of increasing gasoline consumption in case of population growth. Figure 6 and Figure 7 indicate how urban layout could affect the livability of a town center. This result strongly suggests that the dispersion scenario is not recommended for activation of the town center.

It is clear that the compact land-use scenario alone does not always lead to large effects on indicators. The compact land-use scenario with improvement of public transport service shows large compound effects on indicators.

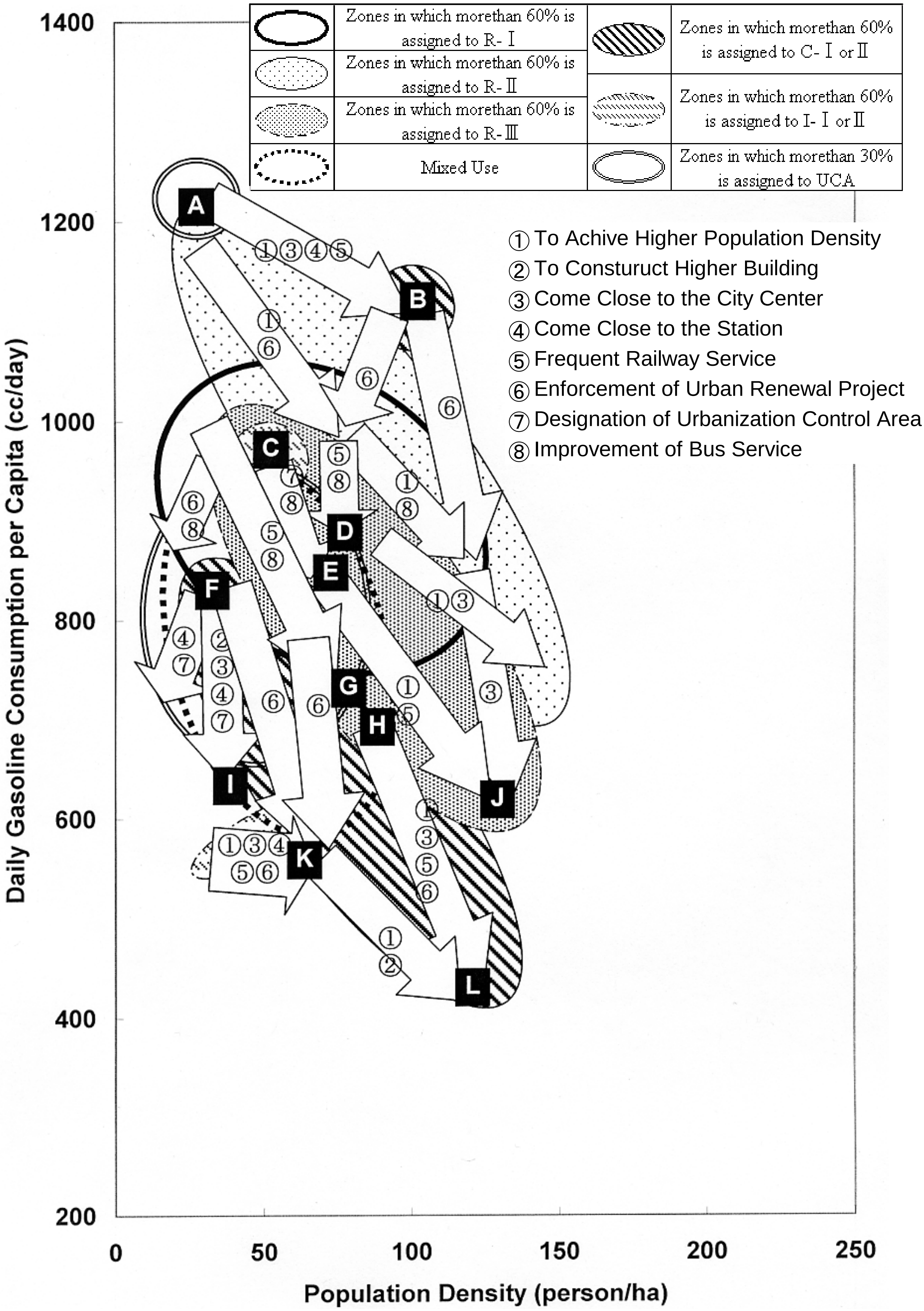

Figure 2. Guideline for improvement of each town (Central City in Local Area)

Daily Gasoline Consumption per Capita (cc/day)	Type	Conditions of Location		Land Use (%)	
1221.3	A	Population Density (person/ha)	27.8	R-Ⅰ	13.0
		Distance from the City Center (km)	7.1	R-Ⅱ	10.5
				R-Ⅲ	25.2
		Distance from the Nearest Railway Station (km)	3.0	C-Ⅰ	0.8
				C-Ⅱ	0.0
		Train Frequency (service/day)	117.4	I-Ⅰ	5.1
		Coverage of Urban Renewal Projects (%)	20.0	I-Ⅱ	8.1
		Density of Bus Stops (number/100ha)	3.4	UCA	37.3
1112.0	B	Population Density (person/ha)	100.7	R-Ⅰ	0.0
		Distance from the City Center (km)	1.5	R-Ⅱ	1.8
				R-Ⅲ	4.9
		Distance from the Nearest Railway Station (km)	1.4	C-Ⅰ	75.2
				C-Ⅱ	14.7
		Train Frequency (service/day)	222.9	I-Ⅰ	1.1
		Coverage of Urban Renewal Projects (%)	33.0	I-Ⅱ	0.0
		Density of Bus Stops (number/100ha)	21.6	UCA	2.2
959.2	C	Population Density (person/ha)	52.1	R-Ⅰ	0.0
		Distance from the City Center (km)	2.9	R-Ⅱ	0.0
				R-Ⅲ	7.9
		Distance from the Nearest Railway Station (km)	1.3	C-Ⅰ	2.9
				C-Ⅱ	0.5
		Train Frequency (service/day)	150.8	I-Ⅰ	82.8
		Coverage of Urban Renewal Projects (%)	28.0	I-Ⅱ	3.2
		Density of Bus Stops (number/100ha)	5.2	UCA	2.7
898.8	D	Population Density (person/ha)	72.1	R-Ⅰ	0.0
		Distance from the City Center (km)	3.6	R-Ⅱ	7.7
				R-Ⅲ	84.1
		Distance from the Nearest Railway Station (km)	2.8	C-Ⅰ	2.8
				C-Ⅱ	0.0
		Train Frequency (service/day)	62.0	I-Ⅰ	1.7
		Coverage of Urban Renewal Projects (%)	52.0	I-Ⅱ	2.2
		Density of Bus Stops (number/100ha)	9.7	UCA	1.5

Daily Gasoline Consumption per Capita (cc/day)	Type	Conditions of Location / Maintenance Situation		Land Use (%)	
820.5	F	Population Density (person/ha)	28.4	R-Ⅰ	61.9
		Distance from the City Center (km)	4.3	R-Ⅱ	7.5
				R-Ⅲ	13.5
		Distance from the Nearest Railway Station (km)	4.3	C-Ⅰ	3.0
				C-Ⅱ	0.0
		Train Frequency (service/day)	182.3	I-Ⅰ	2.8
		Coverage of Urban Renewal Projects (%)	33.0	I-Ⅱ	0.0
		Density of Bus Stops (number/100ha)	4.3	UCA	11.3
614.1	J	Population Density (person/ha)	131.9	R-Ⅰ	3.7
		Distance from the City Center (km)	2.2	R-Ⅱ	3.7
				R-Ⅲ	79.1
		Distance from the Nearest Railway Station (km)	3.1	C-Ⅰ	5.4
				C-Ⅱ	3.4
		Train Frequency (service/day)	168.9	I-Ⅰ	0.9
		Coverage of Urban Renewal Projects (%)	39.0	I-Ⅱ	2.2
		Density of Bus Stops (number/100ha)	11.3	UCA	0.0
552.4	K	Population Density (person/ha)	69.9	R-Ⅰ	0.0
		Distance from the City Center (km)	0.6	R-Ⅱ	0.0
				R-Ⅲ	5.0
		Distance from the Nearest Railway Station (km)	0.6	C-Ⅰ	7.6
				C-Ⅱ	84.8
		Train Frequency (service/day)	222.7	I-Ⅰ	0.7
		Coverage of Urban Renewal Projects (%)	79.0	I-Ⅱ	0.0
		Density of Bus Stops (number/100ha)	17.3	UCA	1.9
441.4	L	Population Density (person/ha)	131.3	R-Ⅰ	0.0
		Distance from the City Center (km)	0.8	R-Ⅱ	0.0
				R-Ⅲ	6.1
		Distance from the Nearest Railway Station (km)	1.8	C-Ⅰ	1.9
				C-Ⅱ	88.7
		Train Frequency (service/day)	248.1	I-Ⅰ	0.0
		Coverage of Urban Renewal Projects (%)	83.0	I-Ⅱ	0.0
		Density of Bus Stops (number/100ha)	19.6	UCA	3.3

Factors to Decrease Automobile Usage

Factors to Increase Automobile Usage

Main Land Use

Figure 3 The feature of typical towns

Table 5. Scenarios for Kure city

Pop. Frame / Urban Layout	No Growth (Pop: 203,056)	Growth (Pop: 240,000)
BAU (Business as usual)	2002 (Base Case)	
Trend	Extend the same population growth trend (these 5 years) for the future	
Dispersion	Allocate the population to low-density suburbs	
Compact	Allocate the population to the central city and public transportation corridor	
Compact + Improve Pub. Transport Service	Compact menu + improve train service	

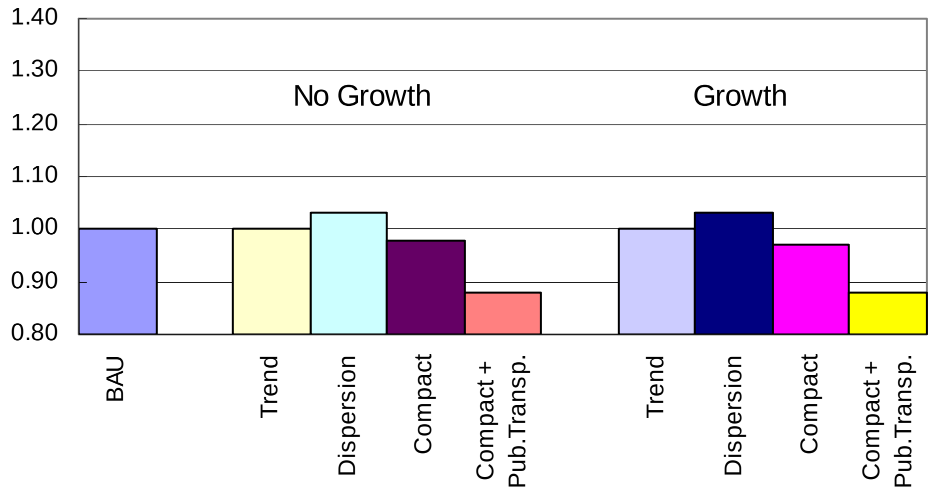

Figure 4. Automobile fuel consumption in each scenario: per capita (Weekday, BAU=1.0)

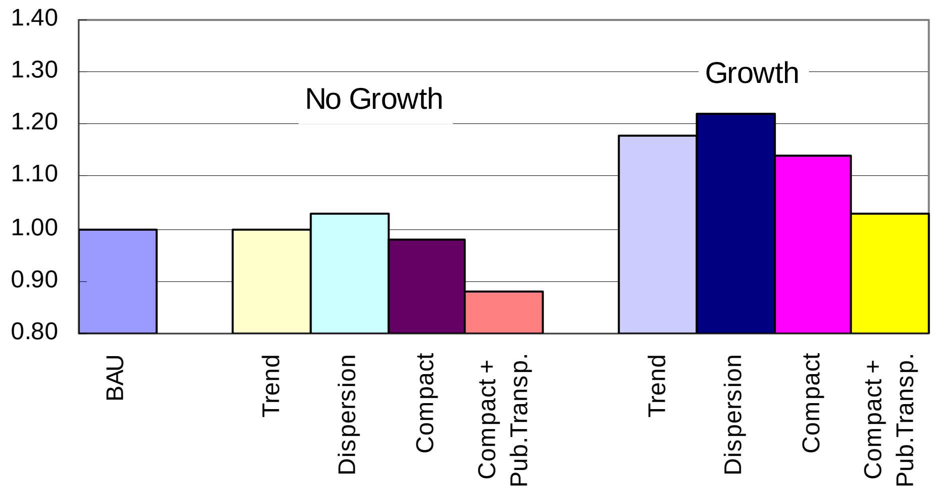

Figure 5. Automobile fuel consumption in each scenario: City total (Weekday, BAU=1.0)

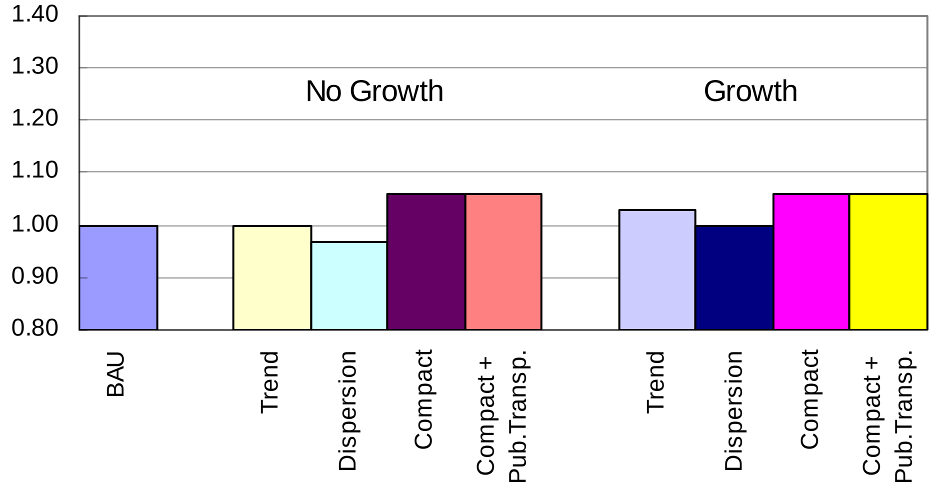

Figure 6. Livability of a town center (Total duration time in the city): per capita (Trip purpose: Free activity) (Weekday, BAU=1.0)

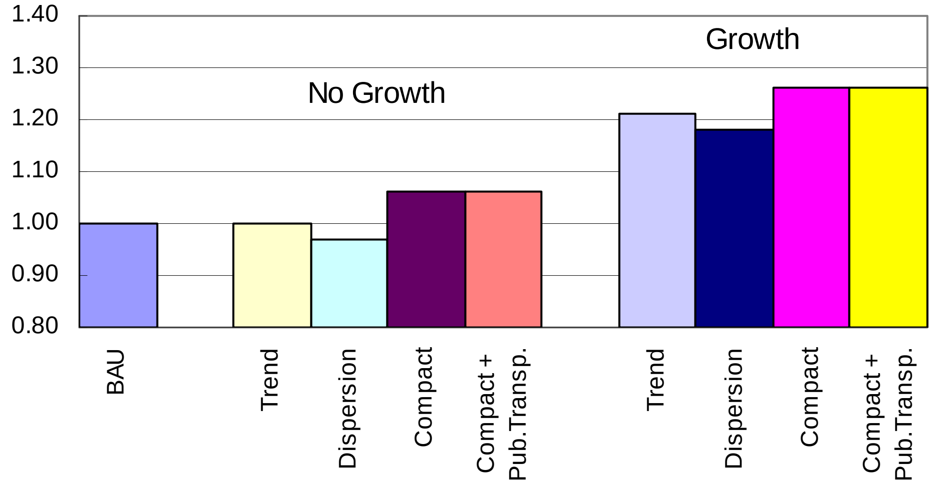

Figure 7. Livability of a town center (Total duration time in the city): City total (Trip purpose: Free activity) (Weekday, BAU=1.0)

6. Conclusion

The results of this study provide many realistic hints to improve urban layout in order to diminish reliance on the automobile and to improve other indicators. Urban density is not the only factor to realize compact urban life. A rough sketch by SLIM CITY indicates the relative influence by each factor, and enough information is provided to choose an appropriate policy mix for a compact city. The results of this study show that gasoline consumption and other dependent indicators could be controlled by improving many factors on a town scale. Land-use regulation, transportation conditions, and infrastructure conditions are included. The effect of infill-type urban development is also confirmed. Moreover, some factors that were believed to have a simple effect on automobile usage show reverse effects under different conditions. A combination of certain countermeasures was found to be very effective. From these findings, it is concluded that SLIM CITY can cover a wide range of evaluation work to realize compact urban form.

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